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ABSTRACT

The present study was conducted to demonstrate the power of imagery instructional sets to improve the recall of units more complex than in the traditional paired associate (P-A) paradigm and to evaluate imagery as a memory organizer. Forty-eight sixth grade children were randomly assigned to one of four experimental conditions, defined by the instructional set subject was trained to use: (1) unitized-imagery; (2) paired-imagery; (3) unitized-repetition; and (4) paired-repetition. The task involved the P-A recall of noun 4-tuples, for which the subject was instructed whether to learn four nouns as one unit or as three separate S-R pairs. Imagery was found to increase total recall, the number of 4-tuples from which nouns were recalled and the organization of recall, with imagery subjects recalling approximately four times as many nouns as repetition subjects. Unitized-imagery instructions resulted in the highest organization of recall, and it is suggested that imagery is potentially a very effective memory organizer. The power of training in a memory technique was demonstrated, and it seems that children's memories can be improved with training. (Author)

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Imagery Organization and Children's Recall[1]

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Mental imagery as an approach to learning and thinking was in vogue with early psychologists (e.g., Titchener, 1909) before the onslaught of behaviorism ended its popularity. However, imagery has recently gained new acceptance as an approach to mediated learning and memory. The first manifestation of this acceptance has been research intended primarily to demonstrate the effectiveness of imagery for improving learning. This research has recently been reviewed by Allan Paivio (1969), who is probably the individual most responsible for the renewed interest in imagery. For research purposes imagery has been operationally defined in two ways: by the concreteness/imagery value of nouns, defined on the basis of rated ease of formation and vividness of an image; and by instructional sets to form images. Paivio (1969) noted the consistent finding that noun concreteness accounts for more of the variance in paired-associate (P-A) recall scores than imagery instructional sets, when both are manipulated in studies involving college students. This conclusion is supported in the research of Paivio and Yuille (1967; and Yuille and Paivio, 1969), and is consistent with the findings of Taylor and his associates investigating P-A recall in children (Taylor, 1969; Taylor and Black, 1969; and Taylor, Peloquin, and Kenworthy, 1969). However, the opposite results have been found with a mnemonic technique involving imagery described by Miller, Galanter, and Pribram (1960), which requires the over-learning of a rhyming serial "peg list" (e.g., one is a bun, two is a shoe, three is a tree, etc.). Bugelski, Kidd and Segmen (1968) suggested that imagery instructions were critical to the effectiveness of this technique. Paivio (1968) clarified

CG 005 491

the issue by manipulating both the concreteness of the "peg list" and imagery instructions, and found that instructional sets accounted for most of the variance attributable to imagery.

Rohwer (1969) has pointed out that almost all the research manipulating imagery instructional sets has been with college students (Ss). One recurring problem in the manipulation of imagery instructional sets has been the limited experimental control over the mediational activities of college Ss (e.g., Paivio, Yuille, and Smythe, 1966; and Persensky and Senter, 1969). Although Taylor and Black (1969) have reported similar problems in controlling imagery instructional sets with children; they have suggested that it should be easier to gain control over the mediational activities of children since younger Ss would be less likely to have their own well-developed mediational strategies. Taylor and Black (1969) proposed the following means of increasing the control over the responses of children given instructional sets; the use of a more complex task for which S is less likely to have a response set; the use of only concrete nouns, since little is known as to the activities Ss perform in order to construct images for abstract nouns; the use of more elaborate training procedures involving feedback and examples supplied by E; and the use of repetition instructions as a means of preventing the control Ss from "doing their own uncontrolled thing". Rohwer (1970, personal communication) suggests support for a similar set of assumptions from a recent P-A study. Rohwer found that the performance of first and sixth grade children given no specific instructional set (NS) was similar to that of Ss given repetition instructions and significantly below the performance of Ss given sentence-generation instructions (see Rohwer, 1966, for an example of these instructions); while eleventh

grade Ss given the MS set not only recalled more words than repetition Ss, but recalled significantly more words than even the sentence generation Ss.

Since the initial research on imagery has shown it to be a potent variable in mediation and memory, some of the attention of researchers interested in imagery has shifted to: the theoretical analysis of the functions of imagery (e.g., Paivio, 1969; Bower, in press; and Rohwer, 1969); and to symposia related to the developmental and educational implications of research on imagery (Reese, 1969: and Taylor, 1970). Although all these recent approaches to imagery stress some aspect of its mediational function, the conclusion of Bower (in press), that imagery functions mainly as a relational-organizer, seems to be particularly descriptive and easily testable. Bower (in press) reports philosophical, behavioral, and experimental evidence for this relational-organizer function of imagery, and other researchers (Tulving, McNulty, and Ozier, 1965; and Frincke, 1968) have found a relationship between a stimulus dimension of noun concreteness-vividness-imagery and both clustering and learning in free recall. Cofer (1968) has also suggested that organization is inherent in sentence structure and mnemonic learning devices (e.g., imagery), but that this organization interferes with the formation of larger and more functional memory units (i.e., "chunks" or "clusters"). It is possible that Cofer's suggestion may be correct with respect to the traditional P-A paradigm, which seems to place limitations on the effectiveness of imagery instructional sets. However, this problem does not seem to have effected Bower and his associates (Bower, Lesgold, and Tieman, 1969; and Bower and Lesgold, 1969), who have used an imagery instructional set that involves the construction of an interacting image of four concrete nouns as a means of insuring organization of an

unassociated list in several free recall studies. Bower (in press) also suggests that college Ss tend to freely generate similar images involving multiple responses to a single stimulus when they are supplied with a "peg list" mnemonic in P-A experiments. The task employed in the present experiment is modified from Bower's tasks and involves the P-A recall of three nouns to a single stimulus noun, which we have called a 4-tuple.

This 4-tuple presentation allows for the manipulation of instructional sets varying in the degree of organization S is instructed to use in learning. For example, in the P-A paradigm, Ss could be instructed to organize the 4-tuple into one unit or they could pair the stimulus individually with each of the responses in the traditional way. Independent of instructions to organize, however, it seems the 4-tuple task should result in large differences between Ss given imagery and repetition instructional sets. If Bower (in press) is correct that imagery primarily functions as a relational-organizer, then the unitized-imagery Ss should be effectively clustering their recall in larger memory units. Since the paired-imagery Ss are still vulnerable to Cofer's (1968) criticisms, it is predicted that the recall of the unitized-imagery Ss will be more highly organized than the recall paired-imagery Ss. It is further suggested that unitized-imagery instructions should lead to significantly more nouns correctly recalled than paired-imagery instructions. Similar findings are not expected for the repetition controls with respect to instructions to organize, since Tulving (1966) concludes that rote repetition leads to improved recall only when it leads to the organization of larger functional memory units.

Method

Subjects

Forty-eight sixth-grade children from a rural-suburban school[3] were randomly assigned to one of four experimental groups, two imagery (unitized and paired) and two repetition (unitized and paired). Each S was tested individually by one of three experimenters (Es), with each E testing four subjects in each of the four conditions. The data from one S in the paired-imagery condition was lost because S reported not attempting to use the instructional set provided; while all remaining Ss reported following the specified instructions.

Materials

All nouns were selected from the norms established on college Ss by Paivio, Yuille and Madigan (1968), who obtained production meaningfulness scores (m), two ratings of imagery-concreteness, C and I, and Thorndike-Lorge frequency (TLF) counts on 925 nouns. Eighty-four nouns rated high on concreteness were selected from this source, and pilot tests were conducted to insure that the words were in the vocabularies of sixth-grade children. The words were then divided into groups of four (4-tuple), and each 4-tuple was checked to insure that there were no direct associations between two or more words within a set. The test word and the other three stimulus words to be recalled were typed on 5x8 cards as shown in Figure 1. Three of the resulting cards were used as training materials, and the remaining 18 4-tupleswere divided into two lists, as shown in Table 1. The lists were matched on m and C for both the stimulus (test) nouns and the response nouns. Line drawings in black ink on white 5x8 cards were used as instructional aids in the training of imagery Ss.

Procedure

All Ss were tested individually and informed concerning the general procedure; that they would be shown cards containing four nouns and be asked to use a special way to remember them. The special ways to remember the nouns were the four conditions resulting from a fully crossed factorial design involving two memory techniques (imagery or repetition) and two levels of organization (unitized and paired). Therefore, Ss in each condition received a different instructional set and the appropriate training procedures.[4] For instance, the unitized-imagery Ss were instructed to imagine one picture containing the iconic referents of all four nouns doing something together. In the paired-imagery training, S was instructed to imagine three separate pictures, one interacting picture for each pairing of the test word with the three remaining nouns. The instructions for the unitized-repetition condition consisted of having S repeat each 4-tuple over and over as one group (e.g., Boy-Lion-Banana-Cup). In the paired-repetition condition S was instructed to repeat three pairs over and over, one for each pairing of the test word with the other three stimulus words (e.g., Boy-Lion, Boy-Banana, Boy-Cup, Boy-Lion, etc.).

The training for all four conditions followed the same general pattern; the individual presentation of three practice cards with a lesser amount of instructional aid accompanying each succeeding card. For example, in the unitized-imagery training the first practice card was accompanied by an integrated picture containing all the referents of the four stimulus words (see Fig. 2). The second practice 4-tuple was accompanied by an instructional card which contained isolated pictorial representations

of each of the four nouns. No instructional aids were given for the third card. In the repetition groups, the experimenter provided verbal instructional aids by repeating the stimulus words over and over in the appropriate manner. After training, S was tested on the three practice cards and asked to describe how he tried to learn the 4-tuples. S was then informed as to the procedure to be followed in the remaining portion of the experimental session and was given an opportunity to ask questions, which E answered only by repeating relevant portions of the instructional set.

List I was presented with each card shown for twenty seconds (5 sec. per word). Immediately after the presentation of the complete list, S was tested on List I by an oral presentation of the test word followed by a recall period (maximum 15 sec./4-tuple) during which S responded verbally. After a brief pause (approximately 30 sec.) List II was presented and tested in the same manner as List I, which was then followed by another 30 sec. pause and a delayed test on List I. The initial tests on the two lists served as repeated measures of immediate recall since the high likelihood of ceiling effects made it impossible to have multiple trials on a single list. While the delayed test served only as a preliminary test of the hypothesis that materials learned under imagery instructional sets would be less subject to interference. Prior to the presentation of the lists the cards were shuffled and the first and last 4-tuples were recorded so that the effects of primacy and recency could be determined. The order of testing was randomly determined and systematically varied so that 3 Ss from each condition were tested with each of 4 random orders on each of the 3 tests.

Results

Data were pooled over experimenters since this extraneous variable produced no significant effects. In addition the separate analysis controlling for primacy-recency effects (i.e., analysis of only seven 4-tuples) was dismissed as it produced results identical to those for nine 4-tuples.

Following the procedures developed by Cohen (1963) to measure clustering in free recall, three related measures were recorded for each S on each of the three tests: words correct (W), the number of response words correct in a given test (maximum = 27); number of categories (C), the number of 4-tuples/test from which S correctly recalled at least one noun (maximum = 9); and words per category (W/C), the ratio expressing the mean of words recalled per 4-tuple in a test (maximum = 3.00). Of the 3 dependent measures W is the best general indicator of recall. However, Cohen (1963 and 1966) has demonstrated that C is quite sensitive to lists and learner differences, while W/C is particularly sensitive to organizational factors and has been found to be nearly a constant for categorized lists (Cohen, 1966). The results for immediate recall were analyzed by a 2 x 2 x 12 x 2 (Imagery x Organization x Ss x Tests) repeated measures anlysis of variance for each of the dependent variables (W, C, and W/C).

The major findings with W as the dependent variable are shown in Figure 3. As expected, the main effect for memory technique was significant, $F(1, 44) = 83.57$, $p < .001$, with this difference between imagery and repetition instructional sets accounting for slightly over half the total variance in recall (est. $\omega^2 = .56$). The Memory technique x Organization interaction was not significant, $F(1, 44) = 1.60$, $p > .05$, with Figure 3 showing the expected trend (i.e., unitization instructions increasing the effects of

imagery and decreasing the recall under repetition instructions). The tests main effect was found to be significant, F (1, 44) = 15.28, $p < .01$; however, since the order of the lists was not counterbalanced, the effect could be due to the increased difficulty of list II or to retroactive interference. All other effects were nonsignificant, $F < 1.0$.

The specific predictions with C, the number of 4-tuples from which at least one noun was correctly recalled, as the dependent measure were that imagery Ss would enter more 4-tuples than repetition Ss, and that the Memory technique x Organization interaction would not be found significant. These hypotheses were confirmed by the data as presented in Figure 4. Imagery training resulted in S entering significantly more 4-tuples than Ss instructed to use repetition, F (1,44) = 66.35, $p < .001$, est. $\omega^2 = .52$. Also as predicted no Memory technique x Organization interaction was obtained, $F < 1.0$. The main effect for tests was again significant, F (1,44) = 9.05, $p < .01$, and as predicted all other affects were nonsignificant.

The results for the mean number of words-recalled per category (W/C) are illustrated in Figure 5. Since W/C was developed by Cohen (1963) as a measure of categorical organization, it is primarily on this dependent variable that instructions to unitize the 4-tuples were expected to be effective. The main effect for memory technique was again demonstrated, F (1, 44) = 48.30, $p < .001$; est. $\omega^2 = .33$, and this effect was modified by the significant Memory technique x Organization interaction, F (1, 44) = 14.04, $p < .01$; est. $\omega^2 = .09$. Two orthogonal planned comparison, that unitized-imagery Ss would recall more W/C than paired-imagery Ss and that imagery instructions would result in higher W/C scores than repetition,

were supported; but the final orthogonal planned comparison, that the two repetition conditions would be equal, revealed an unexpected significant difference in favor of the paired-repetition group (see Fig. 5). However, it is possible that this difference may be accounted for by the statistical deflation of the mean of the unitized-repetition group, which resulted from two Ss recalling no categories and therefore being given a zero W/C score. That this statistical deflation only accounts for part of the difference can be seen in Table 2. The top half of this table presents the group means for each of the dependent measures; and a group measure of W/C calculated by dividing the total words the group recalled, by the number of 4-tuples (C) the group recalled (Cohen, 1966). The lower part of Table 2 shows some representative means reported by Cohen (1966) using lists composed of 3-word exhaustive categories (E, i.e., feminine, masculine, neuter) and 3-word non-exhaustive categories (NE, i.e. dog, horse, cow). Although no statistical test was conducted, an analysis of W/C (group) means suggests that unitized-imagery instructions lead to about the same high degree of clustering (2.43) as Cohen reports for exhaustive categories (2.48); and that the degree of clustering with paired-imagery instructions and non-exhaustive categories is roughly equivalent.

Discussion

The results clearly indicate that children given imagery instructions recall 3 to 4 times as many words as repetition controls. Since most of the previous research using imagery instructional sets has been with college Ss and the magnitude of the differences found with these Ss has not been nearly as large as in the present study, it is possible to hypothesize that imagery

instructions aid the recall of children more than adults. However, the conclusion cannot be quite so broad since Taylor (1969) has frequently found relatively small but significant differences between children instructed to use imagery and control Ss. The present study differs from previous studies (i.e., Taylor, 1969) in several ways including: a more controlled imagery instructional set; the addition of repetition instructions to limit the strategies employed by controls; and the complexity of the 4-tuple task. These factors and not just the use of children as Ss were responsible for the large recall differences found between imagery and repetition groups in the present experiment. The narrow range of means within treatments, the large amount of variance accounted for by the memory techniques factor, and post-experimental subjective reports all confirm the high degree of control maintained over Ss functional learning set; and it seems this control is necessary if imagery is to effectively increase recall.

Although the data is clear with respect to the imagery factor, some discussion seems necessary in regards to organization instructions. That instructions to organize or group nouns does not always increase recall had been suggested by Tulving (1966) and is supported in the present experiment since in no case was there a significant main effect for organization instructions. One conclusion that could be derived from this is that the organization instructions wre not functional. However, that the organization instructions did function as predicted is demonstrated by the interaction between Memory technique and Organization instructions observed when W/C, a measure sensitive to organization, was the dependent variable. Instructions to unitize increased W/C organization for imagery Ss but not for repetition Ss,

however, this effect was not large enough to produce a significant increase in the number of words recalled. The theoretical implications from these findings are that imagery instructions do provide a mediational or relational set, which seems to be functionally similar to the "conceptual peg" hypothesis (Paivio, 1969). Further it seems that the unitized-imagery instructions function to provide a relational-organizer (Bower, in press) in that the recall of these Ss is highly clustered and even approximates the "all-or-none" recall reported by Bower, et al., (1969). Regardless of the specific interpretation it seems quite possible that imagery does function as an organizer (Bower, in press; Tulving et al., 1965; and Taylor, 1969), and that instructions to unitize adds to this by supplying an integrated-relational set. The real test of the value of unitized-imagery instructions is whether they result in an increased number of words recalled; if not, then the significant interaction found in the present study is either meaningless or an artifact of the dependent measure, W/C. The use of W, C, and W/C as dependent measures seems appropriate since Tulving and Pealstone have suggested that these measures serve to breakdown the gross recall measure, W, to its component parts ($W = C \cdot W/C$). That previous research using this measure has been solely in free recall is because the traditional P-A paradigm does not fit the model (i.e., only one response), which the 4-tuple P-A task in the present study seems to be appropriate for.

The use of a new paradigm seems justified in light of: criticisms of the traditional P-A paradigm with mnemonic organizers (Cofer, 1968); the large differences between conditions found in the present study; the possibility of manipulating organization within a 4-tuple; and also the proximity

of such learning to educational concept learning (Carroll, 1964) and learning from text (Frase, 1970). There is nothing magic about 4-tuples, and what might make this modification of traditional P-A recall significant is the possibility of varying the number of responses per stimuli. In fact, in our research group at the present time studies are being conducted using 3-tuples, 5-tuples and 7-tuples, as well as 4-tuples and the traditional 2-tuples. Probably the most interesting thing I have to report about tuples for the present is a study by Russ Cassity and myself which shows Unitized-Imagery far exceeding Paired-Imagery in total recall (W) with only a shift from 4-tuples to 5-tuples. It seems that there is a limit as to the number of unorganized images that can be connected to a single stimulus noun, but judging from the work of Mandler (1967) and Bower, et al. (1969) the limit of a "well" organized mnemonic may be quite high.

It seems that imagery is a functional strategy for improving memory, at least with concrete nouns. In addition, it seems that instructional sets can improve learning and memory in many contexts: learning from text (Frase, 1969) learning from pictures (Davidson, 1964); recalling nouns embedded in sentences (Rohwer, 1970); learning from a mnemonic "peg list" (Paivio, 1968); free recall of nouns (Bower, 1968); and in general learning related to school instruction (Anderson, 1969). Possibly the most important educational implications of research with instructional sets is Bower's (1970) proposal that a "task analysis" of each instructional setting is necessary in order to determine the applicability of specific mnemonic or instructional sets for school learning.

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NOTES

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4. We cannot overemphasize the importance of well defined instructional sets in research on imagery and elaboration. Copies of the instructional sets can be obtained by writing the first author:

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Table 1. Two lists of noun 4-Tuples

List 1			
Nail	Flesh	Mother	Flood
Star	Tower	Peach	Army
Horse	Strawberry	Window	Letter
String	Butter	Cat	House
Brain	Hotel	Table	Magazine
Judge	Hall	Devil	Professor
Flower	Baby	Fox	Engine
Girl	Pole	Library	Umbrella
Railroad	Frog	Rattle	Bowl

List 2			
Hammer	Gold	Insect	Child
Arrow	River	Tree	Potato
Elephant	Doll	Riano	Candy
Circle	Blood	Flag	Corner
Beast	Machine	Student	Village
King	Bird	Truck	Dress
Sugar	Car	Dollar	Whale
Lemon	Officer	Corn	Palace
Toy	Toast	Camp	Slave

Table 2

Means From This Study And Cohen (1966)

Dependent Measures

Conditions	W	C	W/C	(group) W/C
Paired-Repetition	5.79	3.25	1.74	1.79
Unitized-Repetition	4.58	2.91	1.29	1.57
Paired-Imagery	14.88	6.92	2.08	2.15
Unitized-Imagery	16.58	6.83	2.41	2.43
Cohen's E-list	-	-	-	2.48
Cohen's NE-list	-	-	-	2.20

Figure Captions

Figure 1 Sample practice card showing the position of stimulus and three response nouns.

Figure 2 Picture used as the instructional aid to accompany practice card 1 (BOY-LION-BANANA-CUP); note the interacting scene.

Figure 3 Showing the mean number of nouns (W) correctly recalled by the four instructional groups on each of three tests.

Figure 4 Showing the mean number of categories (4-tuples) for which at least one noun was correctly recalled, and the large difference between Imagery and Repetition Ss in the number of categories entered.

Figure 5 Showing the mean number of words per category recalled (W/C); the total number of words recalled by S divided by the number of categories (C) S recalls.

FIGURE 1

BOY	LION BANANA CUP

FIGURE 2

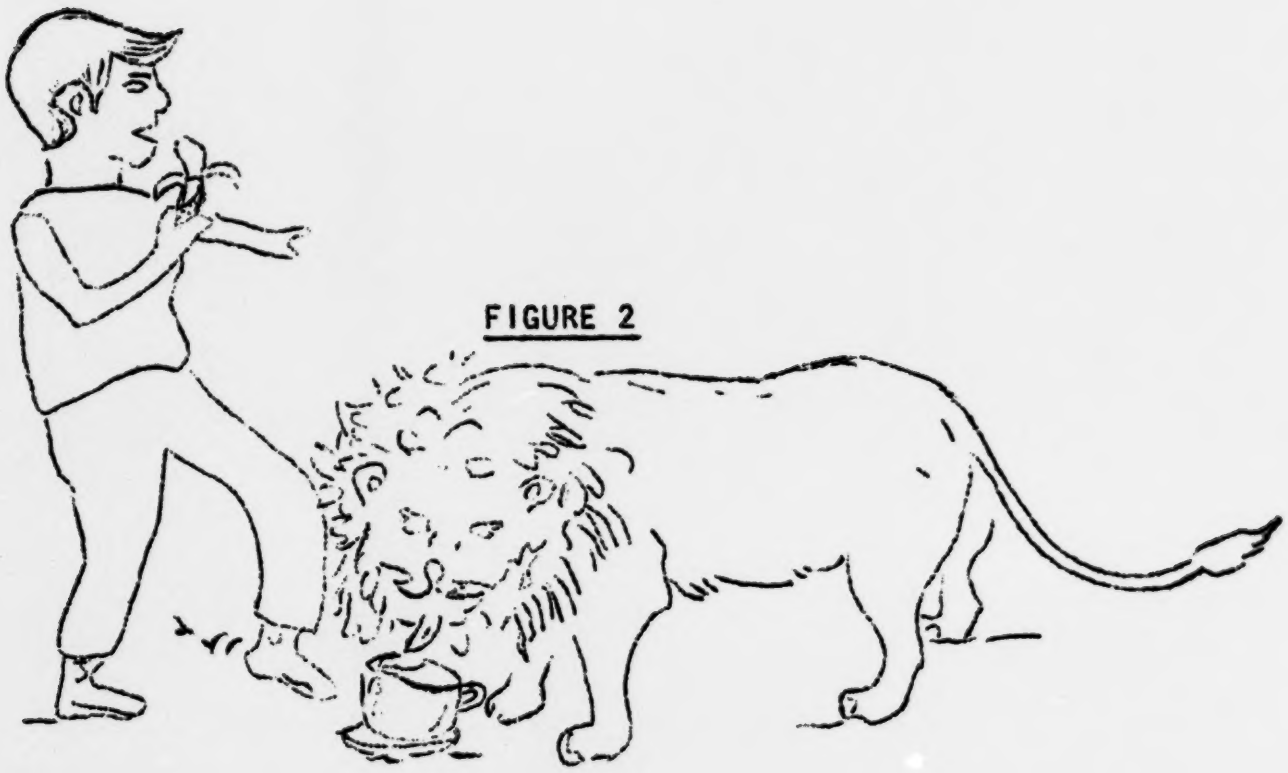
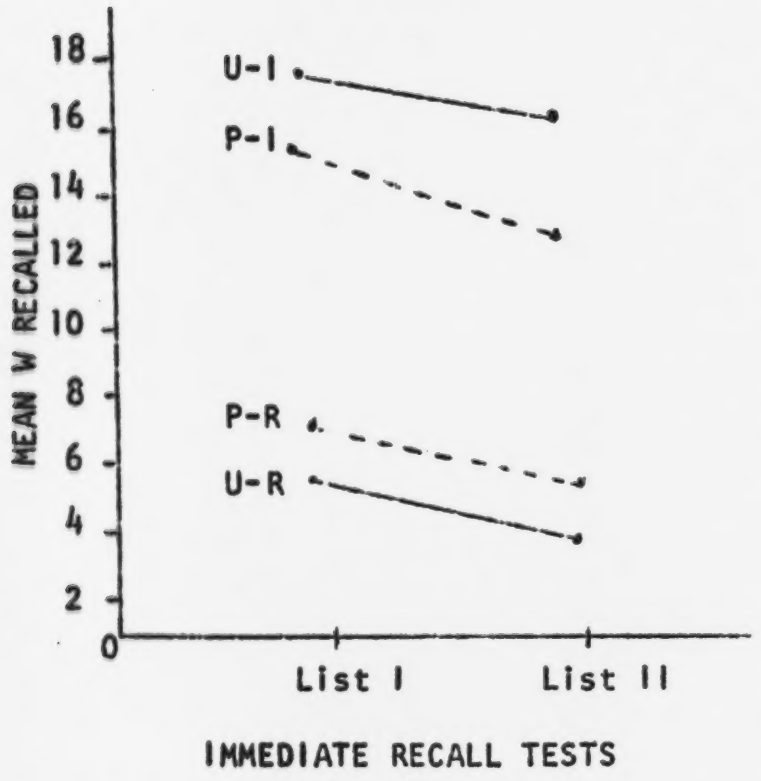


Figure 3



Key for Figures 3, 4, and 5

U-I = Unitized Imagery
P-I = Paired Imagery
U-R = Unitized Repetition
P-R = Paired Repetition

Figure 4

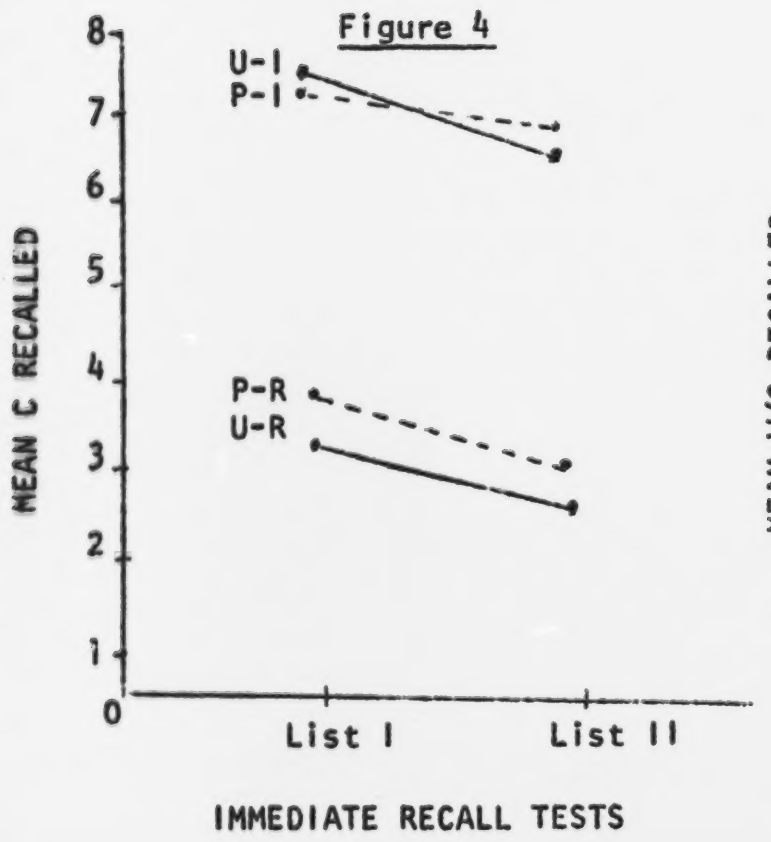


Figure 5